# Water Quality Guidelines for Turkeys

Aviagen Turkeys Ltd ®

## Key points

- Managing water quality is an important factor in successful turkey production.
- Understand the bacteria, pH and hardness of the water source being used and implement daily water line sanitation processes according to local needs.
- Sanitise water lines between flocks.
- Routinely monitor pH, chlorine and ORP levels.

### Introduction

Turkeys typically consume twice as much water as feed, so it is important to provide a clean, healthy water supply. Water not only serves as a vital nutrient but it also impacts virtually every physiological function in the body. Therefore factors which might alter water quality such as changes in bacterial content, pH, nitrogen levels, hardness, alkalinity or mineral levels might directly impact water consumption or the bird's ability to utilise consumed water.
The established guidelines for microbial and mineral water quality for poultry are outlined in Table 1: Water Quality Standards for Turkeys. This table and the factors outlined below should be used to develop a daily waterline sanitation program applicable for the local conditions of the farm.

### Bacteria

The microbial or bacterial test results received from labs are Total Plate Count of Aerobic (oxygen loving) Bacteria (TPC) as measured by CFU/ml (Colony Forming Units/ml). These results do not indicate whether the bacteria present is harmful or harmless but it can tell if the system is dirty and therefore at risk to the presence of less desirable bacteria.

If the total plate count or TPC level is 1000 CFU/ml or less then the water supply is considered acceptable. On farms with excellent water sanitation it is common to see water tests which show 0 CFU/ml even from the end of the drinker line. The closer the water sample results are to 0 CFU/ml the better the water supply is for the modern turkey. Should the test results be greater than 10,000 CFU/ml, it is strongly recommended that the water system be thoroughly cleaned between flocks with an approved cleaner at appropriate concentrations and length of time and then a daily water sanitation program implemented when birds are present.

### pH

pH is the measure of how many hydrogen ions are in solution and is measured on a scale of 1 to 14 with 7 being neutral. A pH reading below 7 indicates an acid with the acidity becoming greater as the numbers become closer to 1. Numbers above 7 are in the basic range of the pH scale. Making a pH change of 1 unit makes a 10 fold change in acidity or alkalinity. So a pH of 6 is 10 times more acidic than a pH of 7.
While pH is not a chemical or specific contaminant, it can impact water quality. It impacts the effectiveness of disinfectants such as chlorine. If water has a high pH then it may be necessary to acidify the water in order to create a favourable pH for effective sanitation with chlorine. Chlorine is most effective in the range pH 4 to 7, but loses effectiveness above pH 8.

## Hardness

Hardness is a measure of the calcium and magnesium in the water. The biggest problem with these minerals is the scale that they form. Scale can reduce the volume of pipes and impact nipple drinkers. It also reduces the effectiveness of cleaners and disinfectants. A water softener can be used to reduce hardness. However sodium based water softeners should not be used if the water already has a high level of sodium.

## Minerals

There is no such thing as pure drinking water as all sources have some amount of minerals dissolved in it. The majority of the time, these dissolved minerals are well within acceptable ranges as the turkey has been shown to be very tolerant of some minerals such as calcium and sodium but very intolerant of minerals such as iron and manganese. Iron and manganese tend to give water a bitter metallic taste and iron also supports microbial growth such as pseudomonas or E. coli. There are many cases of mineral contaminants that are not within desired levels which results in the following issues:

- Poor performance
- Equipment failure or damage
- Presence of harmful bacteria or fungal slime (some minerals can act as a food supply for these).

The minerals calcium and magnesium are the sources of scale, a hard white deposit found in water pipes.
If the water supply contains more than 60 ppm of either or both these minerals and the water pH is above 7 then chances are high that there is scale in the water system that will have to be removed with an acid cleaner designed for nipple drinker systems.

Other common mineral contaminants are iron, manganese and sulphur. Iron results in a rusty brown to red coloured residue, while manganese and sulphur can form black coloured residues. Natural sulphur in the water should have a smell similar to a match head. If the water smells like rotten eggs, then the culprit is hydrogen sulphide. Hydrogen sulphide is a by-product of sulphur loving bacteria and the lines will need to be cleaned with a strong sanitiser. It might even be necessary to shock chlorinate the well. (See appendix 1) If the filters at the beginning of the water lines are rusty or black coloured, then a strong acid cleaner should be used after the sanitiser flush. If iron is a concern, the best method of control is chlorination and filtration.

Nitrates are colourless and odourless and the only way to detect its presence is by testing. As little as 10 ppm nitrate can impact performance causing reduced growth rates and poor feed conversions.

## Cleaning Water Lines Between Flocks

Providing a clean, safe and sanitised water supply is crucial in assuring flocks perform their best. Before implementing a daily water sanitation program, it is important to thoroughly clean as much of the water distribution system as possible to remove biofilm, scale and other deposits.

## Daily Water Line Sanitation

Cleaning the water lines between flocks is only half the battle. Even with a thorough cleaning, if a significant number of bacteria, fungi or yeasts are still present, then the biofilm has the potential to return completely in 2-3 days. Therefore the last step is to establish a daily water sanitation program. This will benefit both the birds and the water system.

Also many of the popular water additive products such as acids and performance enhancers can create conditions favourable for the growth of yeasts and moulds, if they are present. Yeasts and moulds can actually thrive in low pH water resulting in a gooey slime that will clog drinkers and generally create disaster in water systems.
Start birds on fresh sanitized water with 3-5 PPM free chlorine residual at the end of the line or in the drinker farthest from chlorine injection. Add a second injector or medicator and inject an approved acid if the pH is too high. This will enhance the effectiveness of the chlorine.

## Measuring Water Line Sanitation

An important piece of information to know how effective the sanitisation program has been is the ORP value of the water. ORP stands for oxidation-reduction potential and it simply refers to the property of sanitisers such as chlorine to be a strong oxidiser. A strong oxidiser literally burns up viruses, bacteria and other organic material present leaving water microbiologically safe.

An ORP value in the range of 650 millivolts or greater indicates good quality water that can be effectively sanitised by as little as 2 to 4 ppm free chlorine. A lower ORP value such as 250 millivolts indicates a heavy organic load that will most likely overwhelm chlorine's ability to properly disinfect the water.

The ORP meter can be a useful tool for identifying water supplies that don't have adequate free chlorine and for adjusting this without overusing chlorine. It is important to measure the free chlorine level in water. Water with a heavy organic load would result in a greater percentage of bound chlorine resulting in a poor sanitisation.

The bottom line is utilise information on pH, ORP and chlorine level to determine if the sanitation program is effective and to also prevent equipment damage by the overuse of chemicals.

**DO NOT ADD CHLORINE WHEN ADMINISTERING VACCINES, MEDICATIONS, OR VITAMINS.**

**DO NOT MIX CHLORINE AND OTHER PRODUCTS IN THE SAME STOCK SOLUTION**

**Table 1: Water Quality Standards for Turkeys**

| Contaminant, mineral or ion | Maximum Acceptable Level | Comments |
|---|---|---|
| Bacteria<br>**Total Bacteria (TPC) CFU/ml**<br>**Total Coliforms**<br>**Faecal Coliforms** | 1000 CFU/ml<br>50 CFU/ml<br>0 CFU/ml | Total Bacteria is used as an indicator of system cleanliness. High numbers do not necessarily mean the bacteria present are harmful but it does mean that the system is capable of harbouring pathogenic organisms. High bacteria levels can impact taste of water resulting in reduced consumption by birds.<br>Shock well (see appendix 1) then implement sanitation program such as gas chlorine, hydrogen peroxide or other sanitisers. Maintain a residual chlorine level of 3-5 ppm. Adjust pH if necessary.<br>Presence of any faecal coliform means water is unfit for consumption by poultry or humans. |
| pH | 5-8 | pH below 5 can be harmful to drinker equipment by causing corrosion to metal components with long term exposure.<br>pH above 8 impacts effectiveness of most water sanitisers.<br>If pH is lower than 5 soda ash or caustic soda injection will raise pH.<br>If pH is high, acid injection will be required. |
| ORP | 650-700 millivolts | Oxidative Reduction Potential – ORP measures the effectiveness of the sanitation program. |
| Total Hardness | 110 mg/l | Hardness can also be determined by adding the measured Calcium and Magnesium content. Hardness causes scale which can reduce pipe volume and cause drinkers to be hard to trigger or leak. |

| | | |
|---|---|---|
| | | Softeners can remove hardness up to a practical limit of 1700 ppm (or 1700 mg/l). If the hardness is above 1700 ppm or the sodium to hardness ratio is greater than 33% then the sodium level will be high after softening and reverse osmosis may be required. Phosphate injection can be used to form a stable water soluble complex with these minerals effectively reducing the hardness |
| Minerals | | |
| Calcium **(Ca)** | | Problems: No upper limit for Ca, birds are very tolerant of Ca.<br>Treatment: Values above 110 ppm may require water softener, polyphosphates or acidifier to prevent scaling – see Total Hardness |
| Magnesium **(Mg)** | 125 mg/l | Problems: Higher levels of Mg may cause flushing due to laxative effect particularly if high sulphate present.<br>Treatment: Values above 125 ppm may require water softener, polyphosphates or acidifier to prevent scaling – see Total Hardness |
| Iron **(Fe)** | 0.3 mg/l | Problems: Birds are tolerant of Fe metallic taste but Fe causes leaking drinkers and promotes the growth of *E coli* and pseudomonas and is linked to a thick slime producing bacteria such as crenoforms.<br>Treatment: Oxidation with chlorine, chlorine dioxide or ozone and then filtration |
| Manganese **(Mn)** | 0.05 mg/l | Problems: There has been a trend through the years to see problems on farms with Mn in the water. Mn can result in black grainy residue on filters and in drinkers.<br>Treatment: Oxidation with chlorine, chlorine dioxide or ozone then filtration, green sand filtration and softeners to remove Mn Pay close attention to pH when deciding what method to use. |
| Chloride **(Cl)** | 150 mg/l | Problem: When combined with high sodium levels, creates salty water that can act as a laxative causing flushing, also, salty water can promote the growth of *Enterococci* organisms that can lead to enteric issues.<br>Treatment: Reverse Osmosis, anion exchange resin, lower dietary salt level, and blend with non-saline water. Keep water clean and use daily sanitisers such as hydrogen peroxide or iodine to prevent microbial growth. |
| Sodium **(Na)** | 150 mg/l | Problem: When combined with high chloride levels, creates salty water that can act as a laxative causing flushing, also, salty water can promote the growth of enterococci organisms that can lead to enteric issues.<br>Treatment: Reverse Osmosis; lower dietary salt level; blend source with non-saline water. Keep water clean and use daily sanitisers such as hydrogen peroxide or iodine to prevent microbial growth. |
| Sulphates **($SO_4$)** | 200 mg/l | Problem: Sulphates can cause flushing in birds. |

| | | |
|---|---|---|
| | | Treatment: If rotten egg odour present, then bacteria producing hydrogen sulphide are present and system will require shock chlorination plus establishment of good daily water sanitation program, sulphates can be removed by reverse osmosis or anion resin. If $H_2S$ is present (the rotten egg smell) then aerate water into a holding tank and treat with sanitisers then filtration. |
| Nitrates | 25 mg/l | Problem: High nitrate levels can result in poor growth and feed conversions. Presence of nitrates may also indicate faecal contamination so test for bacteria.<br>Treatment: Can be removed with Reverse Osmosis or anion exchange resin. |
| Lead **(Pb)** | 0.014 mg/l | Problem: Long term exposure can cause weak bones and fertility problems in breeders and turkeys.<br>Treatment: Reverse osmosis ,softener or activated carbon will greatly reduce the lead |
| Copper **(Cu)** | 0.6 mg/l | Pipes that contain Cu are very pH sensitive. If the pH is below 5, the piping can begin to be attacked. Above 1 ppm of Cu the water will have an astringent taste. |
| Zinc **(Zn)** | 1.0 mg/l | Pipes that contain Zn are pH sensitive. If the pH is below 5, the piping can begin to be attacked. |

*Note that CFU/ml means colony-forming units of bacteria/ml of water, and mg/l is also the same as parts per million or ppm. The microbial or bacterial test results you receive from labs are Total Plate Count of Aerobic (oxygen loving) Bacteria (TPC) as measured by CFU/ml.*

## References

The Nalco Water Handbook second edition, Frank Kemmer Editor, McGraw-Hill Book Company copyright-1988.
Watkins, S.E., 2002. The campaign for quality drinking water continues. Avian Advice volume 4:3 pp 7-9.
Cornelison, Jana, Melony Wilson and Susan Watkins, 2005. Effects of water acidification on turkey performance. Avian Advice Vol 7:2 pp 1-3.

## Acknowledgements

Dr. Susan Watkins, University of Arkansas.

**Appendix 1: A Procedure for Shock Chlorinating Wells (Anon., 2002)**

For shock chlorination, the goal is to achieve 200 parts per million (ppm) chlorine in the system. Remove any activated carbon filters that might be in the system to prevent filter damage. Household bleach can be used for shock chlorination. Approximately 1.5 litres of bleach per 400 litres water) will give a 200 ppm solution. Caution should be used when handling chlorine compounds and minimize human exposure to chlorine fumes in confined areas such as well houses.

**Step 1** Determine the depth of water in the well. It might be necessary to contact the company that drilled the well to get an exact well depth and water level.

**Step 2** Determine the volume of water in the well. Measure the inside diameter of the well and then refer to Table 1 to determine the volume of water in the well.

**Table 1: Volume of water contained by well depth (Anon. 2002)**

| Well Casing Diameter | Water Volume |
|---|---|
| cm | litres/m of water depth |
| 10 | 8 |
| 15 | 18 |
| 20 | 31 |
| 25 | 49 |
| 30 | 71 |
| 46 | 166 |
| 61 | 292 |
| 76 | 453 |
| 91 | 650 |

**Step 3** Estimate the volume of water in the distribution system and then calculate the total amount of water in the system. Plan for at least 200 litres in the pipelines and also calculate how much is in hot water heaters, holding tanks etc.
**Step 4** Determine the amount of chlorine product required for a 200 ppm solution for all of the water in the system.
**Step 5** Pour the chlorine mixture into the well and distribution system. Dissolve the amount of chlorine solution needed into a clean 20 litre plastic bucket and then slowly poor this into the well but splash it onto the well casing when possible. It is recommended that a hose be attached to a nearby water tap and this be allowed to drain back into the well. This will help mix the bleach with the well water. Once the solution has been placed in the well, then turn on the taps and let run until a strong bleach smell is observed. Turn off taps and let bleach stand in system for 2-3 hours or overnight if possible.

**Step 6** Flush the system to remove the chlorine. The entire system must be emptied of chlorine and thoroughly flushed. Drain the water where it will have a minimal impact on vegetation and animals.

## References

**Anonymous. 2002.** How to Shock Chlorinate your private well supply. http://wilkes.edu/~eqc/shock1.htm



**Aviagen Turkeys Ltd.**
Chowley Five, Chowley Oak Business Park, Tattenhall, Cheshire CH3 9GA
**Tel:** +44 (0)1829 772020 **Fax:** +44 (0)1829 772059

**Web:** www.aviagenturkeys.com